

# DIW Graduate Course: Structural Econometrics in Labor and IO

Peter Haan, Luke Haywood, Daniel Kemptner, Hannes Ullrich

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## 1 General information

### Course objectives

- Covers statistical methods relevant for the analysis of data based on structural economic models
- Discuss advantages and limitations of structural econometric models. Give students an understanding of why and when adding structure is important.
- Focus on discrete choice methods for cross section and panel data
- Provide insights into strategy (especially, identification) in important papers in structural Labour, Public & IO literature. Give a feel of how one may go about establishing a structural model.
- Establish basic estimation techniques & numerical methods such as simulation, numerical integration and discretisation; coding best-practice using Matlab, such as loops vs. vectorisation, readability vs. speed, and sustainable coding for several projects.
- The aim is to equip students with skills allowing them to carry out independent empirical research

### Course organization

- Part I is taught by Daniel Kemptner, Part II by Peter Haan, Luke Haywood, and Hannes Ullrich.
- Credit points: 12 ECTS. 5 sessions in Part I, 8 sessions in Part II. Both parts must be completed to gain credits.
- Prerequisites: skills in advanced econometric methods (Master or Ph.D. level)
- All sessions in this course take place at DIW.
- First session: 20.4.2017
- Final session: 20.7.2017 (Exam)

### Grading

- The overall grade will be the weighted sum of final grades in Part I (40%) and Part II (60%).
- **Part I:** the final grade for this part of the course will be determined by
  - 2 problem sets (to be completed in groups of max. 2 participants), weighted 1/4 each, and
  - a final exam, weighted 1/2.
- **Part II:** the final grade for this part of the course will be determined by
  - 2 problem sets (to be completed in groups of max. 2 participants), weighted 1/3 each, and
  - a final exam, weighted 1/3.

## 2 Part I: Discrete Choice Methods with Simulation

### 2.1 Introduction to Structural Approaches (20.4., PH)

- **Numerical methods** Judd (1998), Train (2009)
- **Methodology fights** Angrist and Pischke (2010), Frijters (2013), Heckman (2010), Keane (2010), Rust (2010), Rust (2014), Wolpin (2013)

#### References

Angrist, Joshua and Jörn Pischke (2010), “The Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics,” *Journal of Economic Perspectives* 24 (2), 3-30.

Frijters, Paul (2013) “The Limits of Inference Without Theory”, *Economic Record* 89, 429-432.

Heckman, Jim J. (2010), “Building Bridges Between Structural and Program Evaluation Approaches to Evaluating Policy,” *Journal of Economic Literature* 48(2), 356-398.

Judd, Kenneth L. (1998), *Numerical Methods in Economics*, MIT Press, Cambridge, MA.

Keane, Michael P. (2010), “Structural vs. Atheoretic Approaches to Econometrics,” *Journal of Econometrics* 156, 3-20.

Rust, John (2010), “Comments on: ‘Structural vs. atheoretic approaches to econometrics’ by Michael Keane,” *Journal of Econometrics* 156 (1), 21-24.

Rust, John (2014), “The Limits of Inference with Theory: A Review of Wolpin,” *Journal of Economic Literature* 52 (3), 820-850.

Train, Kenneth E. (2009), *Discrete Choice Methods with Simulation*, Cambridge University Press.

Wolpin, Kenneth I. (2013), *The limits of inference without theory*, MIT Press.

### 2.2 Introduction to choice models (27.4., DK)

- Train, K.E. (2009), chapters 1, 2
- Properties of choice models
- Binary choice models
- Non-linear models and panel data; Wooldridge, J.M. (2005); Akay, A. (2011)

### 2.3 Logit model (4.5., DK)

- Train, K.E. (2009), chapter 3
- Properties, power, limitations, and estimation
- Kapteyn, A. and F. Teppa (2003)

### 2.4 Unobserved heterogeneity (11.5., DK)

- Train, K.E. (2009), chapters 4-6
- Probit model, taste variation and panel data
- Simulation of choice probabilities
- Mixed logit model; van Soest, A. (1995)

## 2.5 Extensions (18.5., DK)

- Train, K.E. (2009), chapter 7
- Stated- and revealed-preference data
- Revelt, D. and K.E. Train (1998); von Gaudecker, H.-M., A. van Soest, and E. Wengström (2011)
- Ranked data and ordered responses

## 2.6 Simulation-based estimation (25.5. (to be rescheduled), DK)

- Train, K.E. (2009), chapters 8–10
- Numerical integration and drawing from densities
- MSL estimation, MSM estimation, and indirect inference
- Bootstrapping

## 2.7 Papers

- Akay, A. (2011), “Finite-sample Comparison of Alternative Methods for Estimating Dynamic Panel Data Models“, *Journal of Applied Econometrics*, 27, pp. 1189-1204.
- McFadden, D. (2001), “Economic Choices“, *The American Economic Review*, 91 (3), pp. 351-378.
- von Gaudecker, H.-M., A. van Soest, and E. Wengström (2011), “Heterogeneity in Risky Choice Behavior“, *The American Economic Review*, 101 (2), pp. 664-694.
- Kapteyn, A. and F. Teppa (2003), “Hypothetical Intertemporal Consumption Choices“, *Economic Journal*, 113, C140-C152.
- Revelt, D. and K.E. Train (1998), “Mixed Logit with Repeated Choices: Household Choices and Appliance Efficiency Level“, *Review of Economics and Statistics*, 80, pp. 647-657.
- van Soest, A. (1995), “Models of Family Labor Supply: A Discrete Choice Approach“, *The Journal of Human Resources*, 30 (1), pp. 63-88.
- Wooldridge, J.M. (2005), “Simple Solutions to the Initial Conditions Problem in Dynamic, Nonlinear Panel Data Models with Unobserved Heterogeneity“, *Journal of Applied Econometrics*, 20, pp. 39-54.

## 2.8 Textbook

- Train, K.E. (2009), *Discrete Choice Methods with Simulation*, Cambridge University Press.

# 3 Part II: Advanced Topics in Structural Econometrics

## 3.1 Static discrete choice in IO (30.5., DIW - Room Friedensburg, HU)

- Estimating demand and supply parameters in markets with differentiated products using aggregate (product-level) data.
- Coding exercise: preliminaries.

## References

Akerberg, D., L. Benkard, S. Berry, and A. Pakes (2007), “Econometric Tools for Analyzing Market Outcomes,” in J. J. Heckman and E. Leamer, eds., *Handbook of Econometrics*, North-Holland, Chapter 63, 4171-4276, Section 1.

**Berry, Steven T. (1994), “Estimating Discrete Choice Models of Product Differentiation,” *Rand Journal of Economics* 25 (2), 242-262.**

**Berry, Steven T., Jim Levinsohn, and Ariel Pakes (1995), “Automobile Prices in Market Equilibrium,” *Econometrica* 63 (4), 841-890.**

Einav, Liran and Jonathan Levin (2010), “Empirical industrial Organization: A Progress Report,” *Journal of Economic Perspectives* 24 (2), 157-160.

Reiss, P. and F. Wolak (2007), “Structural econometric modeling: Rationales and examples from industrial organization,” in J. J. Heckman and E. Leamer, eds., *Handbook of Econometrics*, North-Holland, Chapter 64, 4277-4415.

### 3.2 Static discrete choice in IO (8.6., DIW - Room Schmoller, HU)

- Recap Berry et al. (1995).
- Coding exercise: Berry et al. (1995) nested fixed-point (NFP) algorithm.
- Discuss extensions and alternative estimation methods.

#### References

**Berry, Steven T., Jim Levinsohn, and Ariel Pakes (1995), “Automobile Prices in Market Equilibrium,” *Econometrica* 63 (4), 841-890.**

Nevo, Aviv (2000), “A Practitioner’s Guide to Estimation of Random-coefficients Logit Models of Demand,” *Journal of Economics and Management Strategy* 9 (4), 513-548.

### 3.3 Dynamic discrete choice in IO (13.6., DIW - Room Friedensburg, HU)

- Introduction to dynamics.
- Estimating single-agent discrete choice models: Rust (1987) engine replacement problem.

#### References

Magnac, Thierry and David Thesmar (2002), “Identifying dynamic discrete decision processes,” *Econometrica* 70 (2), 801-816.

**Rust, John (1987), “Optimal replacement of GMC bus engines: An empirical model of Harold Zurcher,” *Econometrica* 55, 999-1033.**

**Rust, John (1994), Structural estimation of Markov decision processes, In R. Engle and D. McFadden (Eds.), *Handbook of Econometrics* 4, 3081-3143, North-Holland. Amsterdam.**

### 3.4 Dynamic discrete choice in IO (20.6., DIW - Room Friedensburg, HU)

- Coding exercise: Rust (1987)
- Examples of more recent applications to demand estimation.
- Conditional choice probability (CCP) estimation.

## References

- Arcidiacono, Peter and Paul B. Ellickson (2011), “Practical methods for estimation of dynamic discrete choice models,” *Annual Review of Economics*, 3, 363-394.
- Crawford, Gregory and M. Shum (2005), “Uncertainty and learning in pharmaceutical demand,” *Econometrica* 73(4), 1137-1174.
- Gowrisankaran, Gautam and Marc Rysman (2012), “Dynamics of consumer demand for new durable goods,” *Journal of Political Economy* 120(6), 1173-1219.
- Hendel, Igal and Aviv Nevo (2006), “Measuring the implications of sales and consumer stockpiling behavior,” *Econometrica*, 74(6), 1637-1673.
- Hotz, Joseph V. and David A. Miller (1993), “Conditional choice probabilities and the estimation of dynamic models,” *Review of Economic Studies* 60, 497-529.
- Hotz, Joseph V., David A. Miller, S. Sanders, and J. Smith (1994), “A simulation estimator for dynamic models of discrete choice,” *Review of Economic Studies* 61(2), 265-289.

### 3.5 Dynamic discrete choice in Labour (29.6., PH)

- Dynamic incentives to labour supply: investing in human capital
- More on Discretisation
- Interpolation

#### Reference

Keane, M., P. Todd, and K. Wolpin (2011), “The Structural Estimation of Behavioral Models: Discrete Choice Dynamic Programming Methods and Applications,” in *Handbook of Labor Economics*, ed. by O. Ashenfelter and D. Card, Elsevier, vol. 4, 1 ed.

**Keane, Michael and Kenneth Wolpin (1997), “The Career Decisions of Young Men”, *Journal of Political Economy* 105 (3), 473-522.**

### 3.6 Partial and Equilibrium job search (6.7., LH)

- Contrast optimal stopping to equilibrium job search models
- Discuss how on-the-job search generates wage dispersion of observationally equivalent workers
- Identification and estimation using duration data
- Simulation using inverse probability sampling

#### References

McCall (1987)

**Burdett, Kenneth and Dale Mortensen “Wage Differentials Employer Size and Unemployment” (1998), *International Economic Review* 39 (2), 257-273.**

### 3.7 Equilibrium search models (13.7., LH)

- Contrast equilibrium job search with and without firm competition
- Model of firm competition via counter-offers
- Identification and Estimation using duration data
- Inferring productivity dispersion from wage dispersion

## Reference

Postel-Vinay, Fabien and Jean-Marc Robin (2002), “Equilibrium Wage Dispersion with Worker and Employer Heterogeneity”, *Econometrica* 70 (6), 2295-2350.

### 3.8 Exam (20.7.)

### 3.9 Further reading

#### IO: Static demand

Akerberg, Daniel and Rysman, Marc (2005), “Unobserved product differentiation in discrete choice models: estimating price elasticities and welfare effects,” *Rand Journal of Economics*, 36(4), 771-788.

Armstrong, Timothy B. (2013), “Large market asymptotics for differentiated product demand estimators with economic models of supply,” working paper.

Bajari, Patrick L., Fox, Jeremy T., and Stephen P. Ryan (2007), “Linear Regression Estimation of Discrete Choice Models with Nonparametric Random Coefficient Distributions,” *American Economic Review: Papers and Proceedings*, 97(2), 459-463.

Berry, Steven T. and Philip Haile (2014), “Identification in Differentiated Products Markets Using Market Level Data,” *Econometrica*, forthcoming.

Berry, Steven T., Levinsohn, James, and Ariel Pakes (2004), “Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Vehicle Market,” *Journal of Political Economy*, 112(1), 68-104.

Berry, Steven T., Linton, Oliver, and Ariel Pakes (2004), “Limit Theorems for Estimating the Parameters of Differentiated Product Demand Systems,” *Review of Economic Studies*, 71(3), 613-654.

Berry, Steven T. and Ariel Pakes (2007), “The Pure Characteristics Demand Model,” *International Economic Review*, 48(4), 1193-1225.

Chiou, Lesley and Joan L. Walker (2007), “Masking identification of discrete choice models under simulation methods,” *Journal of Econometrics*, 141(2), 683-703.

Dubé, Jean-Pierre, Fox, Jeremy T., and Che-Lin Su (2012), “Improving the Numerical Performance of Static and Dynamic Aggregate Discrete Choice Random Coefficients Demand Estimation,” *Econometrica*, 80 (5), 2231-2267.

Fox, Jeremy T., il Kim, Kyoo, Stephen P. Ryan, and Patrick L. Bajari (2011), “A Simple Estimator for the Distribution of Random Coefficients,” *Quantitative Economics*, 2, 381-418.

Fox, Jeremy T., il Kim, Kyoo, Stephen P. Ryan, and Patrick L. Bajari (2012), “The Random Coefficients Logit Model Is Identified,” *Journal of Econometrics*, 166(2), 204-212.

Fox, Jeremy T., Kim, Kyoo il, and Chenyu Yang (2013), “A simple nonparametric approach to estimating the distribution of random coefficients in structural models,” working paper.

Fox, Jeremy T. and Amit Ghandi (2013), “Nonparametric identification and estimation of random coefficients in multinomial choice models,” working paper.

Freyberger, Joachim (2012), “Asymptotic theory for differentiated products demand models with many markets,” CeMMAP working paper CWP19/12.

Gentzkow, Matthew and Jesse M. Shapiro (2013), “Measuring the sensitivity of parameter estimates to sample statistics,” working paper.

Ghandi, Amit, Lu, Zhentong, and Xiaoxia Shi (2013), “Estimating demand for differentiated products with error in market shares,” working paper.

Heiss, Florian and Viktor Winschel (2008), "Likelihood approximation by numerical integration on sparse grids," *Journal of Econometrics*, 144(1), 62-80.

Hess, Stephane, Train, Kenneth E., and John W. Polak (2006), "On the use of a modified latin hypercube sampling (MLHS) method in the estimation of a mixed logit model for vehicle choice," *Transportation Research Part B: Methodological*, 40(2), 147-163.

Knittel, Christopher R. and Konstantinos Metaxoglou (2014), "Estimation of Random Coefficient Demand Models: Two Empiricists' Perspective," *Review of Economics and Statistics*, 96(1), 34-59.

Nevo, Aviv (2001), "Measuring Market Power in the Ready-To-Eat Cereal Industry," *Econometrica*, 69 (2), 307-342.

Reynaert, Mathias and Frank Verboven (2013), "Improving the performance of random coefficients demand models – the role of optimal instruments," *Journal of Econometrics*, forthcoming.

Skrainka, Benjamin S. (2011), "A large scale study of the small sample performance of random coefficient models of demand," working paper.

Skrainka, Benjamin S. and Kenneth L. Judd (2011), "High performance quadrature rules: how numerical integration affects a popular model of product differentiation," working paper.

Su, Che-Lin and Kenneth L. Judd (2012), "Constrained Optimization Approaches to Estimation of Structural Models," *Econometrica*, 80 (5), 2213-2230.

Train, Kenneth E. (2008), "EM Algorithms for Nonparametric Estimation of Mixing Distributions," *Journal of Choice Modeling*, 1(1), 40-69.

## **IO: Dynamic discrete choice**

Ackerberg, Daniel, Chen, Xiaohong, and Jinyong Hahn (2012), "A practical asymptotic variance estimator for two-step semiparametric estimators," *Review of Economics and Statistics*, 94(2), 481-498.

Aguirregabiria, Victor, and Pedro Mira (2010), "Dynamic Discrete Choice Structural Models: A Survey," *Journal of Econometrics*, 156(1), 38-67.

Aguirregabiria, Victor and Pedro Mira (2002), "Swapping the nested fixed point algorithm: A class of estimators for discrete Markov decision models," *Econometrica*, 70(4), 1519-1543.

Bajari, Patrick, Chernozhukov, Victor, Hong, Han, and Denis Nekipelov (2009), "Nonparametric and semiparametric analysis of a dynamic discrete game," working paper.

Blevins, Jason R. (2014), "Sequential monte carlo methods for estimating dynamic microeconomic models," working paper.

Erdem, T. and Michael Keane (1996), "Decision-making under uncertainty: Capturing dynamic brand choice processes in turbulent consumer goods markets," *Marketing Science*, 1-20.

Hendel, Igal and Aviv Nevo (2014), "Intertemporal price discrimination in storable goods markets," *American Economic Review*, forthcoming.

Larsen, Bradley J., Oswald, Florian, Reich, Gregor, and Dan Wunderli (2012), "A test of the extreme value type I assumption in the bus engine replacement model," *Economics Letters*, 116(2), 213-216.

Norets, Andriy (2009), "Inference in dynamic discrete choice models with serially correlated unobserved state variables," *Econometrica*, 77(5), 1665-1682.

Melnikov, O. (2013), "Demand for differentiated durable products: the case of the US computer printer market," *Economic Inquiry*, 51(2), 1277-1298.

Nair, Harikesh (2007), "Intertemporal price discrimination with forward-looking consumers: application to the US market for console video-games," *Quantitative Marketing and Economics*, 5(3), 239-292.

Pakes, Ariel (1986), "Patents as options: some estimates of the value of holding European patent stocks," *Econometrica*, 54, 755-784.

Reich, Gregor (2013), "The bus engine replacement model with serially correlated unobserved state variables: a deterministic approach," working paper.